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1. AGENCY USE ONLY ( Leave Blank)		2. REPORT DATE 2/24/2003		3. REPORT TYPE AND DATES COVERED Final 15/Apr/99 – 31/Dec/02
4. TITLE AND SUBTITLE Analysis of segmented spatial distributions			5. FUNDING NUMBERS DAAD 19-99-1-0187	
6. AUTHOR(S)				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Div. of Sponsored Programs, Purdue University Hovde Hall West Lafayette, IN 47907			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)  U. S. Army Research Office P.O. Box 12211 Research Triangle Park, NC 27709-2211			10. SPONSORING / MONITORING AGENCY REPORT NUMBER  39136.3 - MA	
11. SUPPLEMENTARY NOTES The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.				
12 a. DISTRIBUTION / AVAILABILITY STATEMENT  Approved for public release; distribution unlimited.			12 b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words)  Together with my PhD student Young Kim, I have explored how to deduce from spatially distributed moving point sets information relevant to situation awareness. A technology assessment of techniques from computational geometry has been augmented with new concepts responsive to customer requirements. The computed information has been presented in a pre-attentive manner to aid rapid comprehension.  In collaboration with Sami Kilic, visiting scientist, and Mete Sozen, Prof. of Civil Engr, I have completed a simulation study of the 9/11 Pentagon attack. Sozen is member of the Damage Assessment team organized by ASCE, and my work is included in the official report. See <a href="http://www.cs.purdue.edu/homes/cmh/simulation">http://www.cs.purdue.edu/homes/cmh/simulation</a> .  Additional findings in the more general setting of computational geometry include an investigation of the practical utility of kinetic data structures, a concept developed by Guibas and Basch at Stanford, and significant advances in geometric constraint solving, a key technology for positioning and moving geometric entities based on constraints. There has also been work on extracting geomtric information from confocal microscopy images.				
14. SUBJECT TERMS Situation analysis, geometric computations, geometric analysis of imagery			15. NUMBER OF PAGES	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OR REPORT <b>UNCLASSIFIED</b>	18. SECURITY CLASSIFICATION ON THIS PAGE <b>UNCLASSIFIED</b>	19. SECURITY CLASSIFICATION OF ABSTRACT <b>UNCLASSIFIED</b>	20. LIMITATION OF ABSTRACT  <b>UL</b>	

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## REPORT DOCUMENTATION PAGE (SF298) (Continuation Sheet)

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### Final Report, Contract 39136-MA *Analysis of Segmented Spatial Distributions*

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#### Problem Statement

Conduct research on fundamental problems in geometric computation for assessing spatial relationships between objects segmented into a few classes. Specific subproblems include, but are not limited to,

- Grouping elements in each class by proximity or by known attributes,
- Reporting elements and groupings of other classes that are closer than threshold distance,
- Visually representing spatial concentrations of elements in a class.

The setting for such problems includes dynamically changing configurations.

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#### Summary of Important Results

Together with my PhD student Young Kim, I have explored how to deduce from spatially distributed moving point sets information relevant to situation awareness. A technology assessment of techniques from computational geometry has been augmented with new concepts responsive to customer requirements. The computed information has been presented in a pre-attentive manner to aid rapid comprehension. The results have been reported in Kim's PhD dissertation on line at

<http://www.cs.purdue.edu/homes/cmh/distribution/Theses/KimThesis.pdf>. Preliminary findings have been reported at the 21<sup>st</sup> Army Science Conference at the University of Maryland (Baltimore County).

In collaboration with Sami Kilic, visiting scientist, and Mete Sozen, Professor of Civil Engr, I have completed a simulation study of the Pentagon 9/11 attack. Sozen is member of the Pentagon damage assessment team, organized by ASCE, and the work is included in their official report. The simulation results can be found at <http://www.cs.purdue.edu/homes/cmh/simulation>.

Additional findings in the more general setting of computational geometry include an investigation of the practical utility of kinetic data structures, a concept developed by Guibas and Basch at Stanford, and significant advances in geometric constraint solving, a key technology for positioning and moving geometric entities based on constraints. There has also been work on extracting geometric information from confocal microscopy images.

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#### Publications

##### (a) Papers published in peer-reviewed journals

- "A Framework for Object Modeling," *CAD 31*, 1999, 541--556; (with V. Kumar, D. Burns, and D. Dutta).
- "Distributed Maintenance of Multiple Product Views," *CAD 32*, 2000, 421--432; (with R. Joan-Arinyo).
- "A Systematic Framework for Solving Geometric Constraints Analytically," *JSC 30*, 2000, 493--520; (with C. Durand).
- "Decomposition plans for geometric constraint problems, I. Performance Measures for CAD." *JSC 31*, 2001, 367--408; (with A.~Lomonosov and M.~Sitharam).
- "Decomposition plans for geometric constraint problems, II. New Algorithms." *JSC 31*, 2001, 409--428; (with A.~Lomonosov and M.~Sitharam).
- "Robustness in Geometric Computations," *JCISE 1*, 2001, 143--155.
- "Towards valid parametric CAD models," *CAD 33*, 2001, 81--90; (with K.-J. Kim).
- "Variable-Radius Circles in Cluster Merging, Part I: Translational Clusters," *CAD 34*, 2002, 787-798; (with C.-S.~Chiang).

- “Variable-Radius Circles in Cluster Merging, Part II: Rotational Clusters,” *CAD* 34, 2002, 799-806; (with C.-S. Chiang).

**(b) Papers published in non-peer-reviewed journals or in conference proceedings**

- “Making complex, multidimensional battlefield information intuitive.” *Proc. 21st Army Science Conference*, Univ. of Maryland, Baltimore, 1998; (with P. Emmerman, J. Walrath, R. Winkler, and Y. Kim).
- “Variational Constraints in 3D,” *Proc. Intl Conf on Shape Modeling and Applications*, 90-97, Aizu, Japan, 1999; (with C. Durand).
- “On Spatial Constraint Solving Approaches,” Springer Lect. Notes in AI 2061, *Automated Deduction in Geometry*, J. Richter-Gebert and D. Wang, eds., Springer Verlag, 2001, 1--15; (with B. Yuan).
- “Solid Modeling,” CRC Handbook on *Discrete and Computational Geometry*, J. E. Goodman and J. O'Rourke, ed., CRC Press, Boca Raton, FL; second edition, in press.
- “Solving Spatial Basic Geometric Constraint Configurations with Locus Intersection,” *Proc. Solid Modeling '02*, 95-104; (with X.-S. Gao and W.-Q. Yang).
- “Parametric Modeling,” *Handbook of CAGD*, J. Hoschek and M. S. Kim, 2002, 519-541; (with R. Joan-Arinyo).
- “Modeling ECM Fibre Formation: Structure Information Extracted by Analysis of 2D and 3D Image Sets.” *Proceedings of Society of Photo-Optical Instrumentation Engineers (SPIE)*, Vol. 4621, pp. 52-56, San Diego, CA, Spring 2002; (with J. Wu, S. Voytik-Harbin, D. Filmer, Bo Yuan, C-S. Chiang, J. P. Robinson).

**(c) Papers presented at meetings but not published in conference proceedings**

- “There are 12 Common Tangents to four Spheres,”  
<http://www.cs.purdue.edu/homes/cmh/distribution/SphereTangents.htm>.

**(d) Manuscripts submitted, but not published**

- “Analysis of orientations of collagen fibers by novel fiber-tracking software” with J. Wu, B. Rajwa, D. Filmer, B. Yuan, C.-S. Chiang, J. Sturgis, P. Robinson.
- “Automated quantification and reconstruction of collagen matrix from 3D confocal datasets,” with J. Wu, B. Rajwa, D. Filmer, B. Yuan, C.-S. Chiang, J. Sturgis, P. Robinson.
- “Making Constraint Solvers more Usable,” (with B. Yuan and M. Sitharam).
- “Dynamic Proximity Calculations for Situation Awareness,” with Y. Kim.
- “Enhanced Battlefield Visualization for Situation Awareness,” with Young Kim.

**(e) Technical reports submitted to ARO**

None.

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**Supported Personnel and Scientific Collaborations**

Young Kim, PhD 2000, presently completing a post-doc at UNC under Prof. Dinesh Manocha.

Gahyun Park, working on her PhD presently.

Ching-Shoei Chiang, visiting professor, now at Soochow University, Taiwan.

Dr. Sami Kilic, visiting scientist, Civil Engr, Purdue University.

Dr. Bo Yuan, visiting scientist, now at Solidworks, Inc, Boston.

J. Paul Robinson, Basic Med Sci, Purdue University.

Mete Sozen, Civil Engr, Purdue University.

Meera Sitharam, CS, Univ. of Florida.

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**Inventions**

None

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**Bibliography**

No additional citations.

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**Technology Transfer**

Simulation study of the 9-11-2001 Pentagon attack. See

<http://www.cs.purdue.edu/homes/cmh/simulation/> for details. The study was cited in the ASCE Pentagon Building Performance Report released 1-23-2003.